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Forest Health Protection

Pacific Southwest Region

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To: District Ranger, Big Valley Ranger District, Modoc National Forest

Subject: Forest insect and disease evaluation, Knox Flat and Moll Reservoir (NE01-09)

On July 18th, Rick Turcotte, Bill Woodruff and Danny Cluck, from the Northeastern California Forest Health Protection Shared Service Area, accompanied by Barbara Zylstra, District Culturist, visited two sites on the Big Valley Ranger District to evaluate forest health conditions and discuss what influence these conditions would have on stand management objectives. We visited two 40-acre stands, Knox Flat (T39N R11E S32) and Moll Reservoir (T38N R10E S23) on the Big Valley RD, Modoc National Forest.

Background Information

Both stands contain two age classes of Jeffrey pine (*Pinus jeffreyi),* ponderosa pine *(Pinus ponderosa),* white fir *(Abies concolor),* and western juniper *(Juniperus occidentalis),* with most trees being less than 110 years old. Scattered throughout the stand, are a few old (200+ years) Jeffrey and ponderosa pines. Based on the numbers of large old stumps and standing trees, it is evident that both stands were stocked with fewer trees (estimated 5 to 20 trees/acre) 100-150 years ago. Annual precipitation in these stands is between 16 and 25 inches and falls mainly as snow. Elevation ranges from 5300 to 5800 ft.

These stands will be managed for a natural-appearing landscape using even-age and uneven-age silvicultural prescriptions. Emphasis will be on the production of saw logs and miscellaneous wood products. All management activities are subordinate to maintaining the visual quality objective of partial retention.

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Field Observations

Knox Flat

The Knox Flat stand consists of Jeffrey pine ranging in size between 12-24" DBH and a few white fir and western juniper. The understory is serviceberry (*Amelanchier utahensis)* and mountain mahogany (*Cercocarpus ledifolius),* with a few scattered Jeffrey pine seedlings, saplings and poles. The stand density index (SDI) is 234, the basal area is 153 ft^2 per acre and the site class is a Meyer's 3.

Five groups of standing dead and downed Jeffrey pine trees were detected. These groups ranged in size from 6-10 trees, to pockets of 45 or more that covered up to a 1/2 acre. All dead or downed trees sampled had Jeffrey pine beetle (*Dendroctonus jeffrey*i) galleries and the boles had been heavily infested with round-headed and flat-headed woodborers. Based on the condition and the extent of the decomposition of these trees it appears that they were killed in the early 1990's during the last protracted drought period (1987-1994). The dead and down trees have contributed to an increase in fuel loadings in these areas.

A low level of needle injury was present on several understory pine caused by adult *Scythropus sp.* weevil feeding. In addition, pine needle scales (*Chionaspis pinifolie)* were present on the needles of several pole-sized pines and several large white fir trees had dead tops, which is likely the result of fir engraver (*Scolytus ventralis)* activity.

Moll Reservoir

The Moll Reservoir stand consists of Jeffrey pine, ponderosa pine, white fir and western juniper ranging in size between 12-24" DBH. The understory is white fir, Jeffrey pine, ponderosa pine and western juniper. The slope is 15-20%. Shallow soils are evident in spots where a number of large pine trees were wind-thrown more than ten years ago. The SDI is 238, the basal area is 124 ft^2 per acre and the site class is a Meyer's 4.

The only bark beetle activity noted included several large pines, which had been attacked and killed by mountain pine beetle (*Dendroctonus ponderosa)* and red turpentine beetle (*Dendroctonus valens).* This was presumably the result of bark beetles being the attracted to the deeply cut blaze marks in these trees.

Active p-type annosus root disease, caused by the fungal pathogen *Heterobasidion annosum,* is present. Several western juniper trees have been recently killed by annosus root disease. The dead juniper trees are near the stumps of old infected (conks found in stumps) ponderosa pine and Jeffrey pine scattered through the stand. Other diseases present in the stand include a light elytroderma (*Elytroderma deformans*) infection in many of the crowns of the understory pine trees and a light infestation of true mistletoe (*Phoradendron densum)* in some of the older juniper trees.

Management Options

No Action: - Overstocked stands tend to have higher levels of bark beetle related mortality compared to those that have tree densities more appropriate for the site. The basal area of the stands will continue to increase over time. Openings already created in the stand as a result of the group kills do not have an effect on the density of the surrounding stand or on the stand's susceptibility to future drought and bark beetle-related mortality. Periods of below normal precipitation will increase the probability that some trees in the overstocked stands will be attacked by bark beetles, similar to the group kills that occurred on the Knox Flat site during the last protracted drought period. Although, some mortality may be desired for snags, small openings and for future down wood debris, the no action option will most likely result in an unacceptable level of tree mortality. Mortality levels will typically be above background levels as stand density increases and will be accentuated during periods of below normal precipitation. Additional bark beetle- related mortality would further increase the total fuel accumulation and fire hazard.

Annosus is a gap former, creating openings in the forest of varied sizes. If susceptible host species regenerate active annosus centers, the likelihood of these trees reaching maturity is low. Although the overall effect of these centers on the overall Moll Reservoir site are expected to be minimal, continued pine and juniper mortality is expected in areas adjacent to infected pine or juniper trees or stumps.

Salvage: – Salvage sales can minimize the economic loss and reduce the amount of dead fuel; however, these operations will have no effect in reducing or controlling future bark beetle populations. In addition, all of the mortality currently present in the stand is a result of attacks that occurred several years ago. Since the bark beetles also emerged several years ago there would be no effect on populations in either leaving or removing the dead trees.

At the present time, there are no biologically effective or economically efficient methods available to directly reduce bark beetle populations (direct control) on an area-wide basis such that tree mortality will be reduced to acceptable levels. Direct control of Jeffrey pine beetle through removal of green infested trees is supported by FHP however this practice requires the identification and removal of infested trees prior to crown fade and therefore is not typically practiced in general forest areas.

Stocking control: - Both stands are currently above the SDI threshold of 230 for ponderosa and Jeffrey pine stands in northern California (Oliver & Uzoh 1997). An SDI of 230 defines a zone of "imminent bark beetle mortality" within which tree kills by endemic populations of bark beetles begin but the net growth of the stand remains positive. The limiting SDI for pine stands, as suggested by these authors, is 365. Stands that approach this level can have high levels of bark beetle-related mortality.

Thinning is perhaps the most critical silvicultural treatment available to restore and maintain tree health in these stands. Management activities should focus on maintaining a basal area of below 150 ft^2/ac. or an SDI of <230, from now to the next scheduled stand entry. Silvicultural

prescriptions that reduce the basal area or SDI should result in lower levels of bark beetle-related mortality in the future. Following thinning, it is expected that pine mortality would continue to occur and fluctuate in response to the amount of available moisture, but at levels that, through time, would more closely approximate naturally occurring mortality.
Depending on what species mix is desired to meet the management objectives for these stands thinning activities should attempt to leave as much of the residual basal area in pine and other more drought tolerant species and should select against white fir. White fir existing in areas receiving 20-25 inches of annual precipitation are at the lower limit of their range during normal precipitation periods. When conditions such as protracted drought or overstocking occur white fir in these stands become predisposed to attacks by the fir engraver. Although some white fir may survive for long periods in these stands it is not prudent to attempt to maintain this species as a significant stand component.

Often several years are required before an increase in growth and vigor occurs following a thinning project, therefore, it is recommended that these types of activities (such as thinning or other silvicultural practices) be implemented prior to the onset of drought periods or elevated levels of bark beetle activity. Stand improvement activities should be minimized as much as possible during periods of elevated tree stress and extra care should be taken to prevent damage to residual trees during all projects.

Annosus root disease management:

- **Control: -** If total control of annosus root disease is desired, all pine and juniper trees within 30 feet of symptomatic trees or infected stumps must be removed. Note: Any large stump that was not treated with a borate fungicide at the time of harvest is likely to be infected with annosus root disease. In addition, no pine or juniper should be grown in these treated areas for the next thirty years, after which time all the diseased roots should be decayed. This level of treatment may be unwarranted considering the small amount of annosus present in the stand that at this time.

- **Species conversion:** - Because of the host specificity of the different types of annosus, favoring a more resistant species is often possible. If pine is infected, favor true fir. If true is infected, favor pine or incense cedar. Unfortunately, due to the low amount of precipitation at this site, true fir is not an appropriate species to plant.

- **Prevention: -** Regardless of the time of the year or how the current annosus centers are managed, it is highly recommended that all conifer stumps 12 inches or greater during chainsaw felling, or 8 inches or greater during mechanical shearing be treated with a registered annosus fungicide. Sporax® is the only fungicide registered for controlling annosus root disease on stumps in California. Stumps are susceptible to annosus infection immediately after cutting. For maximum effectiveness, it is imperative to apply Sporax® to all freshly exposed stumps.

If you have any questions regarding this report please call any of the forest health protection staff at 530-257-2151.

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Additional information on Insects and Diseases

Jeffrey Pine Beetle, *Dendroctonus jeffreyi*

The Jeffrey pine beetle is the principle bark beetle found attacking Jeffrey pine, which is its only host. It is a native insect occurring from southwestern Oregon southward through California and western Nevada to northern Mexico. The beetle normally breeds in slow-growing, stressed trees. The beetles prefer trees which are large, mature, and occur singly rather than in groups. Yet when an epidemic occurs, the beetle may attack and kill trees greater than 8 inches in diameter in groups, regardless of age or vigor. Often the beetle infests lightning-struck or wind-thrown trees, but does not breed in slash.

Evidence of Attack

Presence of the beetle is usually detected when the foliage changes color. The color change of the foliage is related to the destruction of the cambium layer by the beetle. Generally, the top of the crown begins to fade in a slow sequence, with the needles turning from greenish yellow, to sorrel, and finally to reddish brown. By the time the tree is reddish brown, the beetles have usually abandoned the tree. Another sign of beetle attack is large, reddish pitch tubes projecting from the bark of the infested tree. If examined carefully, pitch tubes can be detected on infested green trees prior to crown fade. Jeffrey pine beetles have a distinctive "J" shape egg gallery pattern on the inner bark. Larval mines extend across the grain and end in open, oval-shaped pupal cells.

Life Stages and Development

The Jeffrey pine beetle is one of the larger pine bark beetles in California. The beetle has 4 life stages, egg, larva, pupa, and adult. The adults are stout, cylindrical, black, and approximately five-sixteenths of an inch long when mature. The egg is oval and pearly-white. The larva is white, legless, and has a yellow head. The pupa is also white and is slightly smaller than the mature larva. The life cycle is normally completed in one year in the northern part of the range, but in the southern part, two generations per year may occur. The principle period of attack is in June and July, but attacks also are frequent in late September and early October. Similar to other *Dendroctonus* species, Jeffrey pine beetles use pheromones that attract other beetles to a tree, causing a mass attack that tends to overcome the tree's natural resistance. Blue stain fungi are associated with Jeffrey pine beetle attacks and aid in overcoming the tree.

Conditions Affecting Outbreaks

Normally the Jeffrey pine beetle is kept in check by its natural enemies, climatic factors, and the resistance of its host. Similar to other *Dendroctonus* species, the availability of suitable host material is a key factor influencing outbreaks. Healthy trees ordinarily produce abundant amounts of resin, which pitches out attacking beetles. When deprived of moisture, trees cannot produce sufficient resin flow and they become susceptible to successful beetle attacks.

Fir Engraver, *Scolytus ventralis*

The fir engraver attacks red and white fir in California. Fir engraver adults and developing broods kill true firs by mining the cambium, phloem, and outer sapwood of the bole, thereby girdling the tree. Trees greater that 4 in diameter are attacked and often killed in a single season. Many trees, weakened through successive attacks, die slowly over a period of years. Others may survive attack as evidenced by old spike-topped fir and trees with individual branch mortality. Although many other species of bark beetles cannot develop successful broods without first killing the tree, the fir engraver beetle is able to attack and establish broods when only a portion of the cambium has been killed.

Evidence of Attack

Fir engravers bore entrance holes along the main stem, usually in areas that are greater than 4 inches in diameter. Reddish-brown or white boring dust may be seen along the trunk in bark crevices and in spider webs. Some pitch streamers may be indicative of fir engraver attacks; however, true firs are known to stream pitch for various reasons and there is not clear evidence that pitch streamers indicate subsequent tree mortality. Resin canals and pockets in the cortex of the bark are part of the trees defense mechanism. Beetle galleries that contact these structures almost always fail to produce larval galleries as the adults invariably abandon the attack. Pitch tubes that are often formed when bark beetles attack pine are not produced on firs.

Adults excavate horizontal galleries that engrave the sapwood; the larval galleries extend at right angles along the grain. Attacks in the crown may girdle branches resulting in individual branch mortality or "flagging". Numerous attacks over part or all of the bole may kill the upper portion of the crown or the entire tree. A healthy tree can recover if sufficient areas of cambium remain and top-killed trees can produce new leaders. The fir engraver is frequently associated with the roundheaded fir borer and the fir flatheaded borer.

Life Stages and Development

In the summer, adults emerge and attack new host trees. The female enters the tree first followed by the male. Eggs are laid in niches on either side of the gallery. Adult beetles carry a brown staining fungi, *Trichosporium symbioticum*, into the tree which causes a yellowish-brown discoloration around the gallery. The larvae mine straight up and down, perpendicular to the egg gallery. Winter is commonly spent in the larval stage, with pupation occurring in early spring. In most locations, the fir engraver completes its life cycle in 1 year, however at higher elevations 2 years may be required.

Conditions Affecting Outbreaks

Fir engravers bore into any member of the host species on which they land but establish successful galleries only in those which have little or no resistance to attack. Populations of less aggressive species like fir engraver are likely to wax and wane in direct relationship to the stresses of their hosts. Drought conditions often result in widespread fir mortality however

attempting to determine when outbreaks will occur is difficult. Lowered resistance of trees appears to be a contributing factor. Overstocking and the increased presence of fir on sites that

were once occupied by pine species may also contribute to higher than normal levels of fir mortality. Several insect predators, parasites and woodpeckers are commonly associated with the fir engraver and may help in control of populations at endemic levels.

Red turpentine beetle, *Dendroctonus valens*

The red turpentine beetle occurs throughout California and can breed in all species of pines. It normally attacks injured, weakened or dying trees and freshly cut stumps. The adults are attracted by fresh pine resin. They often attack wounded trees, trees scorched by wildfire or prescribed burns, lightning-struck trees and root-diseased trees exhibiting resinosis. Attacks usually occur at the soil line or root crown and are characterized by a large reddish pitch tube at the point of entry. On severely stressed trees or during periods of drought, attacks may occur underground on the main roots up to 15 feet from the bole and also on the bole to a height of 10 feet. If an attack is successful, the adults excavate an irregular gallery in the cambium and the female lays eggs along the sides. The larvae feed in a mass and destroy an area of cambium ranging from 0.1 to 1.0 square feet. Attacks do not always kill trees but may predispose them to attack by other bark beetles. Repeated or extensive attacks by the red turpentine beetle can kill pines.

Attacks occur throughout warm weather and peak at mid-summer. The number of generations varies from two years for a single generation at the coldest portions of its range to two or three per year in the warmest.

Wood boring beetles

There are a number of species of flat-headed borers (family Buprestidae) and round-headed borers (family Cerambycidae) that mine in the sapwood, and in some cases the heartwood of dead or dying trees. Most of the western species are cambium wood-feeders with broad host ranges. These beetles are commonly found around timber harvest sites, burned areas, blow-down patches, and other locations where disturbance creates a sudden abundance of weakened or dead trees. Attacks can occur concurrently with, or just after bark beetle attacks and may continue for as long as 4-5 years.

The common features of all wood boring beetles are their strong association with various wood decay fungi and their role as recyclers of wood. The larvae create long, meandering tunnels within the host tree and rapidly transform the wood into finer particles that are more readily decomposed by fungi. Many of the species have a one-year life cycle and spend most of that time in the larval stage. Attacks can be minimized or prevented by avoiding soil compaction and injury to standing trees during logging or construction and also by insecticide application to high value trees.

Scythropus weevils, *Scythropus* sp.

The life histories of *Scythropus* weevils are not well documented. Information available on *S. californicus*, a coastal insect, states that the eggs are laid in rows in a tube consisting of three previous year pine needles glued together. Upon hatching, the larvae drop to the ground and

feed on rootlets. Pupation and over-wintering occurs in the soil. The life cycle is believed to span two years. This species attacks needles that are at least two years old. The adults bite out chunks and leave a saw-toothed pattern that often causes the needle to die and drop prematurely. They are considered only as a minor pest of ornamentals, and none have ever been reported to cause any economical damage to forests.

The Pine Butterfly, *Neophasia menapia*

The pine butterfly is a pest of ponderosa pine and Douglas-fir (*Pseudotsuga menziesii)*. The adult is a white butterfly with black markings. Adults usually fly in August, September and October. The female lays small emerald-green eggs, which are attached to needles in the upper crown. Larva emerge in late spring, and feed in clusters, similar to sawfly larva. Late instar larvae feed individually and mature by late July. Mature larvae attach themselves to needles, twigs or bark before changing into pupae. This insect in conjunction with bark beetles is reported to have caused extensive amounts of damage and tree mortality in ponderosa pine stands in the late 1800's and early 1900's in the Pacific Northwest.

Annosus root disease of pine*, Heterobasidion annosum*

Heterobasidion annosum is a fungus that attacks a wide range of woody plants, causing a decay of the roots and lower bole and death of the sapwood and cambium. At least two host specific forms have been identified: a p-type, which infects pines, incense-cedar, western juniper, and hardwood, and a s-type, which infects firs, Douglas fir, spruce, western cedar, giant sequoia and hemlock. All pines species in California are susceptible.

The fungus produces spores in fruiting bodies (conks). Air-borne spores land on, germinate, and grow in freshly cut stumps. The fungus then grows into the root system and may spread to adjacent healthy trees via root contacts. Infected pines are usually killed in less than a year since *H. annosum* girdles pine trees at the root collar. After a suitable period of time, conks are produced under the bark of dead trees, in decayed stumps, or in the duff at the root collar.

Local spread of *H. annosum* outward from a stump results in the formation of disease centers that have dead trees in the middle and dying trees on the margin. These centers usually continue to enlarge until they reach barriers such as openings or groups of non-host plants. The fungus may remain alive for as long as 30 years as a saprophyte in infected roots and stumps. Susceptible species may seed in or be planted in centers and survive for a few years, but they eventually can be infected and die if their roots contact diseased roots.

Elytroderma needle disease*, Elytroderma deformans*

The fungus *Elytroderma deformans* causes the most serious needle disease affecting ponderosa and Jeffrey pine in California. Lodgepole, knobcone, Coulter and pinyon pines are occasional hosts. Unlike other needle diseases, elytroderma infects the twigs and branches, allowing for an annual infection of the hosts new needles. Elytroderma's impact can be considerable in forests primarily managed for recreation, where the unsightly appearance of infected trees and the occasional resulting mortality can degrade the visual quality and health of a stand.

Fungus fruiting bodies release spores from infected needles in the late summer and early fall. Spores are wind borne, and if environmental conditions are suitable, they germinate and infect the current year's needles. Initially, the fungus grows through the needle and into the twig without killing the needle. The following spring, infected needles die and turn a reddish-brown color. Infected branches take on a characteristic appearance, with the current years' needles looking green and healthy while the one-year-old infected needles are reddish-brown. Under suitable conditions, long and narrow black fruiting bodies, called hysterothecia, form on some dead needles and mature later in the summer, completing the cycle.

Elytroderma disease kills one-year-old needles prematurely and deforms infected twigs and branches. Generally, pines are little affected if fewer than 40 percent of the twigs are infected. The disease seldom kills mature trees directly, but moderate to severe infections can predispose these trees to bark beetle attack. This disease is most severe on seedlings, saplings, and pole sized trees that are suppressed or have thin crowns. Disease outbreaks are uncommon, but once started, the disease can persist for many years, particularly on moist sites.

Cypress-Juniper Mistletoe, *Phoradendron densum*

Dense mistletoe is a leafy mistletoe and is the only mistletoe that attacks juniper. Clusters of mistletoe shoots occur on the branches throughout the hosts' crown. The shoots bear narrow, long greenish leaves that are usually readily visible. This is a parasitic plant that can only survive by growing in living tissues, principally as a water parasite utilizing water and minerals from the host.

This plant is spread mainly by birds, including robins, bluebirds, thrushes, and cedar waxwings. Birds feed on the berries, digest their pulp, and excrete the living seed, often depositing them onto susceptible trees. A viscous coating and hair-like threads on the outer surface of the seeds attach them firmly to twigs and branches, where they germinate and infect host tissues.

In nearly all cases, initial infection occurs on the upper branches of larger or older trees because birds prefer to perch in their tops. Severe buildup of mistletoe often occurs in an already-infected tree because birds are attracted to and may spend prolonged periods feeding on the mistletoe berries.

Heavily infected trees are weakened, have reduced growth rates, and sometimes are killed. Weakened trees are predisposed to attacks by insects and often die during drought or other periods of stress. Severe infection can also result in top-kill. Branches and tops heavily laden with true mistletoe often break during windstorms, increasing the hazard to people and property in campgrounds and other developed sites.

True mistletoe is recognized by the clumps of mistletoe foliage in the tree. Mistletoe plants are usually located in the tops of larger, older trees. With severe infections, mistletoe plants may replace virtually all of a tree's foliage.

References

Anonymous. 1994. Chapter 60 Management of specific pests. In: Forest Pest Management Handbook, FSH 3409.11, Region 5 Supplement, 3409.11-94.1. 7 pp.

Ferrell, G.T. 1991. Fir Engraver. USDA Forest Service Insect and Disease leaflet 13. 8 p.

Furniss, R.L. and V.M Carolin, 1977, Western Forest insects. USDA Forest Service Miscellaneous Publication 1339. 654 p.

Laudenslayer, W. F., H. D. Hermann and S. Smith. 1989. Historical effects of forest management practices on the eastside pine communities in Northeastern California. In: Multisource Management of Ponderosa Pine Forests, Gen. Tech. Rep. RM-185, Nov. 14-16, Flagstaff, Arizona.

Laudenslayer W. F and C.N. Skinner. 1995. Past climates, forest and disturbances of the Sierra Nevada, California: Under-standing the past to manage for the future. Trans. of the Western Sec. of the Wildlife Society 31: 19-26 p.

Oliver W.W. and F. C. C. Uzoh. 1997. Maximum stand densities for ponderosa pine and red and white fir in northern California. In: Proceedings of the Eighteenth Annual Forest and Vegetation Management Conference, Jan. 14-16, 1997. Sacramento, California.

Scharpf, Robert F. tech. coord. 1993. Diseases of Pacific Coast Conifers. Agric. Handbook 521. 199p.

Smith, R.H. 1971. Red turpentine beetle. USDA Forest Service Insect and Disease leaflet 55. 8 p.

Smith, R. H. 1971. Jeffrey pine beetle. USDA Forest Service Insect and Disease leaflet 11. 7 p

Taylor, A.H. 1998. Final Report “Changes in Fire Regimes, Land Use and Forest Structure since European Settlement in the Lassen National Forest, California”. On file, Supervisors Office, Susanville, California.